Mitchell & Reichert

A PARTIAL STUDY

OF THE

POISON OF HELODERMA SUSPECTUM (COPE)—THE GILA MONSTER.

BY

S. WEIR MITCHELL, M.D.,

AND

EDWARD T. REICHERT, M.D.,

OF PHILADELPHIA.

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FOR some years past it has been known to naturalists that the Gila lizard of Arizona and Sonora was endowed with anterior deciduous grooved teeth, which communicated by ducts with large glands within the angle of the lower jaw. These arrangements naturally suggested a certain power of poisoning, as to which, however, the most conflicting accounts have reached, and continue to reach us from Arizona. In many houses the sluggish creature shown to you was a pet of children, and seems to have been averse to using his weapons of offence. The occasional accidents from his bite were variously explained away; but still, among the Indians and some settlers, he enjoyed an evil reputation. Only within a week we have had two letters from Arizona, the one describing him as "more peaceful and harmless than a young missionary," and the other as being "worse than a whole apothecary shop." Nevertheless, both in France, and of late

in London, specimens have bitten and promptly killed small animals.

It is worth while to mention more distinctly some of the evidence for and against the poisoning power of Heloderma. His bad name in Mexico is mentioned by Bocourt and Dumerei, but Sumichrast is more full in his statements.

This curious lizard is, he says, slow and embarrassed in his movements, and hides in the daylight, and especially in dry weather, to emerge at night and in wet seasons. He is said to smell ill, in fact to be of a nauseating odor, and is described as slobbering forth a sticky, whitish saliva when irritated. The natives, says Sumichrast, hold him in the utmost terror, and consider him as more fatal than any serpent. When made to bite a fowl, it died in twelve hours, with bloody fluid exuding from its mouth, the wound being of a purple tint. A cat bitten was very ill, but recovered, remaining thin and weak. The Heloderma horridum sent to London, to Sir John Lubbock, killed a frog in a few minutes, and a guinea pig in three minutes.

Many years ago Dr. Irwin,[1] U. S. A., experimented in New Mexico with the Gila monster, and concluded it to be harmless, while Mr. Horan, Superintendent of the National Museum, says he himself has been several times bitten without serious results. The following statement of Dr. Shufeldt adds a further difficulty in making up our estimate of the powers of Heloderma. The lizard he speaks

[1] Am. Naturalist, November, 1882.

of is the one we now exhibit. (The lizard was now shown.) It was sent to the Smithsonian by A. T. Burr, U. S. A., and is the H. suspectum of Cope.

On the 18th inst., in the company of Professor Gill of the Smithsonian Institution, I examined for the first time Dr. Burr's specimen, then in a cage in the herpetological room, It was in capital health, and at first I handled it with great care, holding it in my left hand, examining special parts with my right. A the close of this examination I was about to return the fellow to his temporary quarters, when my left hand slipped slightly, and the now highly indignant and irritated Heloderma made a dart forward and seized my right thumb in his mouth, inflicting a severe lacerated wound, sinking the teeth in his upper maxilla to the very bone. He loosed his hold immediately and I replaced him in his cage, with far greater haste, perhaps, than I removed him from it.

By suction with my mouth, I drew not a little blood from the wound, but the bleeding soon ceased entirely, to be followed in a few moments by very severe shooting pains up my arm and down the corresponding side. The severity of these pains was so unexpected that, added to the nervous shock already experienced, no doubt, and a rapid swelling of the parts that now set in, caused me to become so faint as to fall, and Dr. Gill's study was reached with no little difficulty. The action of the skin was greatly increased, and the perspiration flowed profusely. A small quantity of whiskey was administered. This is about a fair statement of the immediate symptoms; the same night the pain allowed of no rest, although the hand was kept in ice and laudanum: but the swelling was confined to this member alone, not passing beyond the wrist. Next morning this was considerably reduced, and further

reduction was assisted by the use of a lead-water wash.

In a few days the wound healed kindly, and in all probability will leave no scar; all other symptoms subsided without treatment, beyond the wearing for forty-eight hours so much of a kid glove as covered the parts involved.

After the bite our specimen was dull and sluggish, simulating the torpidity of the venomous serpent after it has inflicted its deadly wound, but it soon resumed its usual action and appearance, crawling in rather an awkward manner about its cage.—*American Naturalist*, November, 1882.

The specimen shown has eaten once since we have had him, but the Gila monster is said to live on bird eggs, and to eat daily of like food while in captivity.

The sluggish habits ascribed to Heloderma in general have been noticed in our specimen; but it is clear from Dr. Shufeldt's accident that, like the habitually inert Crotalidæ, this creature is capable of sudden, and therefore unexpected, agility in attack.

As we shall have sent to us in the spring a number of Helodermas, we shall then be able to complete the study of the poison of these interesting lizards—the only members of the family of lizards as yet known to be poisonous. The subject is, however, too full of interest to delay the publication of our preliminary study, since, as far as it has gone, it is perfectly definite and satisfactory.

The Gila monster inhabits the dry hillsides of Arizona, and is said to reach the length of three

feet. The specimen we exhibit is about fourteen inches long, and from war or accident had when he reached us lost all but two of his teeth, and as yet no new ones have taken their places. Without them he would certainly be as harmless as a rattlesnake deprived of his fangs; and as these teeth are very small, and easily removed, their absence may account for some of the instances in which the lizard has bitten and done no grave harm.

Experiments made in the usual vague way, by allowing the lizard to bite animals, are obviously untrustworthy; so that it was thought best to use the saliva in known quantities. The fluid was obtained by provoking the animal to bite on a saucer-edge—which it was most indisposed to do. When once it had seized the saucer it was hard to pull it away, so powerful was the grip of the lizard's jaws. After a moment, a thin fluid like saliva dripped in small quantities from the lower jaw. It was slightly tinted with blood, due to the violence of the bite, and it had a faint and not unpleasantly aromatic odor. The secretion thus collected from the mouth was distinctly alkaline, in contrast to serpent venoms, which are all alike acid.

Experiment I.—About four minims were diluted with one-half cubic centimetre of water, and thrown into the breast muscles of a large, strong pigeon, at

4.23 P. M. In three minutes the pigeon was rocking on its feet, and walking unsteadily. At the same time the respiration became rapid and short, and at the fifth minute feeble. At the sixth minute the bird fell

in convulsions, with dilated pupils, and was dead before the end of the seventh minute.

The first contrast to the effects of venom was shown when the wound made by the hypodermic needle was examined. There was not the least trace of local action, such as is so characteristic of the bite of serpents, and especially of the Crotalidæ.

The muscles and nerves responded perfectly to weak induced currents, and to mechanical stimuli.

The heart was arrested in the fullest diastole, and was full of firm black clots. The intestines looked congested. The spine was not examined.

Experiment II.—In the following experiment a full-grown etherized rabbit was used, and the left carotid being connected with the Kymographion, one-sixth of a grain of dry Heloderma venom dissolved in one cc. of distilled water, was injected into the external jugular vein.

Action on the Arterial Pressure.

	Time. min. sec.	Pressure. mm.	Remarks.
Normal,		110	
Injection,	.0		
	.3	100	
	.5	80	
	.10	60	
	.15	70	
	.20	66	
	.30	50	
	1.	50	
	2.	44	
	3.	32	
	4.	26	
	5.	20	
	8.30		
	10.		
	10.30		
	11.10		
	11.30		Convulsive movements.
	12.		
	12.30		The pressure gradually declining to 7 mm., when the animal expired.
	14.30		
	15.		
	16.		
	17.		
	18.		
	19. Death.		

Action on the Pulse.

	Time. min. sec.	Pulse. in 10 sec.	Pulse Curves. mm.	Remarks.
Normal,		57	.7	
Injection,	.0			
	.15	57	1.0	
	.30	54	1.2	
	1.	51	1.0	
	2.	53	.8	
	3.	56	.7	
	4.	61	.6	
	5.	61	.5	
	8.30	56	.4	Convulsive movements.
	10.	47	.5	
	10.30	27	1 6	
	11.10	31	1.0	
	11.30	19	1.2	
	12.00	22	.8	
	12.30	28	.3	
	14 30	63	.2	
	15.	58	.3	
	16.	63	.2	Convulsive movements.
	17.			
	18.			Too feeble to count.
	19.			
	Death.			

Experiment III.—The following experiment was made on a full-grown rabbit in which the pneumogastric nerves were cut, and in which the same dose and method of injection were used; the object being to determine if the above nerves were in any way connected with the changes in the circulation observed in the preceding experiments.

Action on the Arterial Pressure.

	Time. min. sec.	Pressure. mm.	Remarks.
Normal,		80	
Injection,	.0		
	.8	66	
	.15	52	
	.30	56	Convulsive movements.
	.40	60	" "
	.50	42	" " stopped.
	1	34	
	.10	28	" "
	.30	24	" "
	.35	30	Violent convulsions, followed by death in 30 seconds. During these convulsions the canula became detached from the artery.
Death in 1 min. 35 sec.			

Action on the Pulse.

	Time. min. sec.	Pulse. in 10 sec.	Pulse Curve. mm.	Remarks.
Normal,		46	.6	During the last half of the first minute, and after, the tracing was so irregular on account of the convulsive movements that the pulse could not accurately be counted.
Injection,	.0			
	.15	47	.8	
	.30	44	1.0	
	1.00	52	.3	
	1.30			
	1.35	Violent convulsions.		

The animal died in convulsions with dilated pupils.

The results were identical with those obtained when the pneumogastrics were entire, so that the effect on the heart is direct, and not by inhibition through the pneumogastrics.

The results of the autopsy in both of the above experiments are identical, and may be summed up as follows:

Autopsy, made immediately after death.—Heart arrested in diastole; heart does not react to induction currents; muscles everywhere respond to electric stimulation; motor nerves intact; cord unirritable, and will not respond to the strongest current produced by one large gravity cell, with Du Bois Reymond's induction coil; bowels still irritable; peristaltic movements occur spontaneously; the intestines are natural in color, as are all other organs. After five minutes the heart began to contract, and was finally found in a systolic condition. The interior of the organ was full of black clots, especially the auricles, the left ventricle containing but a very small clot.

In order still further to determine the effect on the heart, the following experiments were made:

Experiment IV.—

hrs.	min.	
7.	33	Pithed frog and exposed the heart.
	.52	Heart beats 21 in 30 seconds.
	.52½	Placed a small portion of dried venom of Heloderma on the heart.
	.56	Heart beats 20 in 30 seconds.
8.	05	" " 19 " "
	.18	" " 18 " "
	.30	" " 15 " "
	.43	" " 14 " "
	.55	" " 10 " "
9.	30	" " ceased.

Experiment V.—

hrs. min.

8.05 Took two "cut-out" hearts of frogs, and placed them in a normal salt solution in separate vessels, just sufficient liquid being used to cover the hearts. On one heart was placed a small quantity of dried venom.

.27 The poisoned heart beats more feebly than the other.

.30 " " " " still more feebly than the other, which is yet firm.

.45 The poisoned heart stopped beating, the other beats firmly.

.55 The poisoned heart stopped beating, the other beats firmly but slower.

Experiment VI.—

3.45 Exposed the hearts of two pithed frogs.

4.00 Placed on one some dried venom.

.30 The poisoned heart beats are decidedly feebler than the other.

.50 The poisoned heart beats more feebly; the unpoisoned heart beats firmly and apparently in a normal manner.

6.00 The poisoned heart beats very feebly and does not fill with blood. The normal heart beats firmly, and fills well with blood at each beat, making a striking contrast with the poisoned heart.

We may conclude that—

The poison of Heloderma causes no local injury.

That it arrests the heart in diastole, and that the organ afterwards contracts slowly—possibly in rapid rigor mortis.

That the cardiac muscle loses its irritability to stimuli at the time it ceases to beat.

That the other muscles and the nerves respond readily to irritants.

That the spinal cord has its power annihilated

abruptly, and refuses to respond to the most powerful electrical currents.

This interesting and virulent heart poison contrasts strongly with the venoms of serpents, since they give rise to local hemorrhages, and cause death chiefly through failure of the respiration, and not by the heart, unless given in overwhelming doses.

They lower muscle and nerve reactions, especially those of the respiratory apparatus, but do not, as a rule, cause extreme and abrupt loss of spinal power.

Finally, they give rise to a wide range of secondary pathological appearances, which are absent from Heloderma poisoning.

There remains on our minds no doubt as to the fact that the fluid which drips from the mouth of Heloderma when it bites is a very active poison. The present study is, however, limited in range, and we cannot yet feel sure that the fluid in question comes from the glands now presumed from their relation to the teeth to be poisonous.

The briefest examination of the lizard's anatomy makes clear why it has been with reason suspected to be poisonous, and why it poisons with so much difficulty. Unless the teeth are entire, the poison abundant, and the teeth buried in the bitten flesh so as to force it down into contact with the ducts where they open at the crown of the teeth, it is hard to see how even a drop of poison could be forced into the wounds. Yet it is certain that small animals may die from the bite, and this may be due

to the extraordinary activity of the poison, and to the lizard's habit of tenaciously holding fast to what it bites, so as to allow time for a certain amount of absorption.

It is plain enough that a lizard as small as the one exhibited would be very unlikely to inflict a wound fatal to man; but it is possible that the larger animal—and it is said to reach a length of three feet—might prove a more efficient poisoner.

We are unwilling to drop the subject without a few words as to the nature of this poison.

The recent researches of Dr. Sternberg and Prof. Gautier have shown that human saliva may kill a rabbit in twenty-four hours, according to the former observer, and a pigeon in a few hours, he does not say how many, according to the latter, if a quantity of saliva have been concentrated by heat and so used. Professor Gautier thinks the saliva and all venoms owe, at least, a part of their power to normal ptomaines or animal alkaloids, the products of putrefactive processes, and recalls to us the fact that most secretions are measurably poisonous.

The answer to these views we shall have to consider elsewhere, and at length, but it will be sufficient here to say that there is no resemblance between the symptoms caused by the known ptomaines and those produced by any of the venoms. When it was shown that healthy human saliva was competent to kill, it was natural enough to leap to the conclusion that the venoms were merely concentrated salivas. The analogy ends with the fact that both may cause death, but the one may kill in

twenty seconds, and the other requires, at the least, many hours, whilst also it seems, as regards saliva, to be, in some degree, a question of the toxic activity of certain individuals, not all being so uncomfortably endowed as Dr. Sternberg himself.